PILINGS WITH WIRE OR GEOTEXTILE FENCING

Pilings with wire or geotextile fencing are single or double rows of pilings with wire mesh, wire, or geotextile on the streamside of the fence. The pilings are driven parallel to the streambank, and the mesh, wire, or geotextile slow the flow of water through the fence. By slowing the speed of the water, the bank is protected from the force of fast-flowing water.

Pilings with slotted fencing are a single or double row of pilings with planks between the posts instead of wire fencing. The slotted fencing makes a slightly sturdier structure than the wire fencing. The space between the bank and fence or between the two fences can be filled with brush and trees as well.

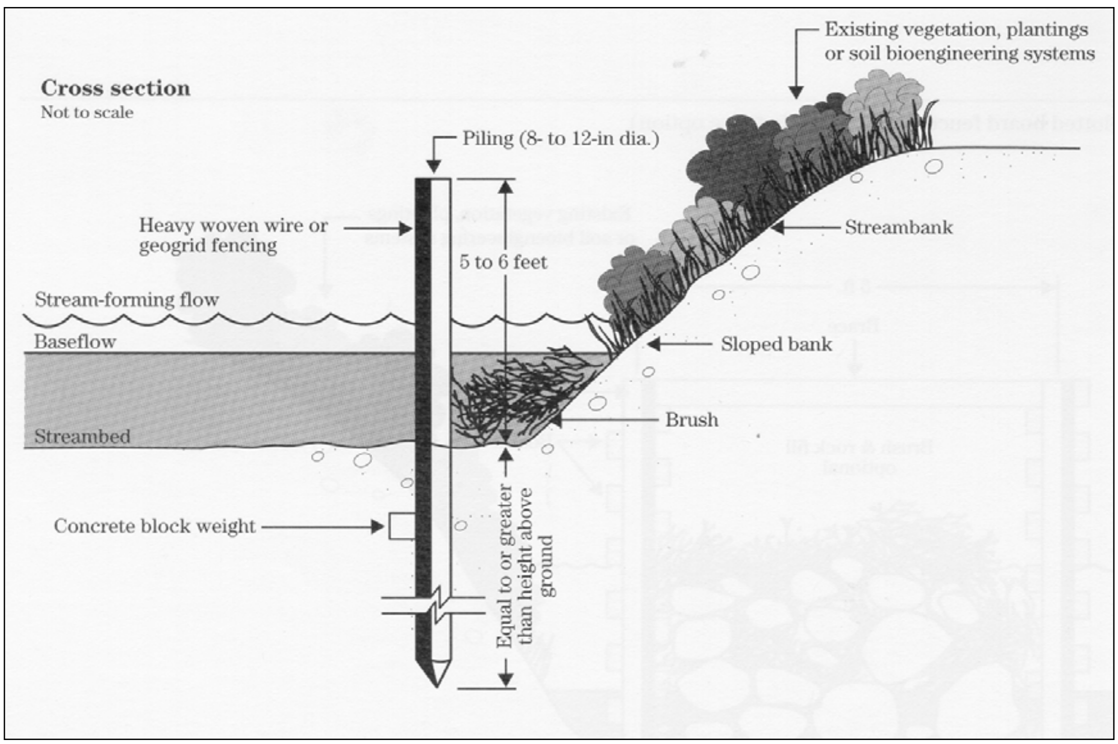


Figure 18. Piling revetment details

Advantages and Disadvantages

- The stream needs to be at least three feet deep.
- Pilings work well in deeper streams, but should not be used when the piling length exceeds nine feet.
- Pilings can be damaged by ice and debris flows.
- Pilings are not recommended to maintain or enhance riparian wildlife habitat.

Materials

- Eight- to twelve-inch-diameter wood with a length equal to twice the bank height at the point of entry.
- Heavy woven wire or geotextile fabric.

Preparation

- Select several pilings made from timbers, logs (see Lumber section on page 9), or pipe (materials should not be toxic).
- Obtain woven wire or geotextile fabric.
- Obtain or rent equipment capable of driving the selected piling materials in the stream bed.
- Select rock and brush for the space between a double row of pilings.
- Clear the stream bottom of debris along the alignment of the wire fencing to allow for its installation.

Installation

- Drive pilings six to eight feet apart with half of the length of the piling driven into the deepest part of the eroding streambed.
- If a double row of fencing is being created, the second row is placed five feet up the slope from the first row.
- Attach the wire, mesh, or geotextile fabric to the streamside of the pilings.
- If a double row of pilings is used, fill the space between the two rows with rock and brush.

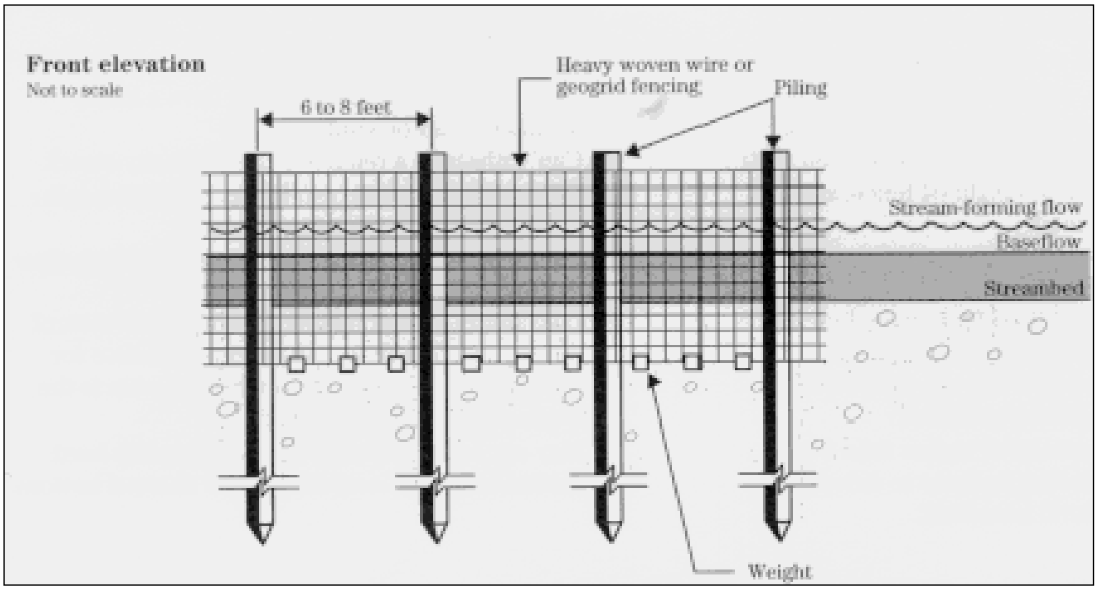


Figure 19. Diagram of wire fencing between posts

RIPRAP

Riprap is a layer of various-sized rocks used to protect a streambank from erosion.

Figure 20. Riprap along the bend of a stream with vegetation between the rocks

Advantages and Disadvantages

- Riprap is effective because the rock can adjust to the contours of the streambank and vegetation can grow among the rocks to provide habitat for wildlife in and above the stream.
- Riprap is easy to install and repair, has a natural appearance, and does not harm the environment.
- Riprap works well with a combination of soil bioengineering techniques used up the slope.

Materials

- Class D or E revetment stone, preferably broken limestone, dolomite, or quartzite, available from most quarries (see the Riprap section on page 9). Rough, angular surfaces and variety of sizes will allow the rock to fit together tightly to form a dense barrier.

Preparation

- Determine the stream's velocity by dropping a wood chip into the stream and counting the number of seconds it takes for the chip to travel 50 feet. Divide 50 by the number of seconds to get the stream's velocity in feet per second. Table 2 describes the sizes for riprap based on the speed at which water flows when the stream is at high-flow conditions.

Table 2. Recommended sizes for riprap

Velocity of stream during high flow	Size range (diameter across longest part of rock)
Slow (2-4 ft/sec)	3" - 6"; average 4"
Moderate (4-6 ft/sec)	4" - 12"; average 8"
* Fast (6-12 ft/sec)	5" - 18"; average 14"

*****This velocity is the most common cause of streambank erosion in Iowa.

- Use a rock size that the velocity of the stream will not be able to move when the stream is at high-flow conditions.
- The rock used for riprap on fast-flowing streams should weigh between 5ive and 150 lbs, with most of the stones weighing at least 90 pounds.
- Smaller rocks should be included in the mixture to fill in the spaces between the larger rocks.
- Broken concrete can be used if the pieces vary in size (well-graded) and the steel reinforcement rods have been removed.
- Broken asphalt should not be used, because of its toxicity to riparian wildlife and low density.
- Rubble from the demolition of buildings should not be used if it contains wood, wallboard, plaster, etc.
- Junk such as washing machines, cars, tires, and refrigerators should never be used. In many cases, junk littering a streambank aggravates the erosion problem.
- Before installing riprap, the bank should be reshaped to a maximum slope of 2 feet horizontal to 1 foot vertical (2H:1V) or flatter.

Installation

- A geotextile fabric can be used after the slope has been graded to stabilize the soil.
- Place a 6-inch layer of gravel or crushed stone, and then firmly place the riprap. If a properly chosen filter/engineering fabric is used, gravel or crushed rock does not need to be used.
- The rock should be inspected to ensure a variation of rock size throughout the slope, and the largest, heaviest rocks should be placed along the bottom of the bank. The rocks should form a layer 12 to 18 inches thick.
- The rock should generally cover the bank from the bottom of the stream to the level of a 2-year or 5-year storm. The remainder of the eroding bank should be reshaped and planted with trees, shrubs, and grasses, as described in the previous sections of this document entitled Seeding of Streambank and Live Stakes.
- If streambed scouring is anticipated, extend the riprap into a trench across the streambed so that if the current makes the channel deeper, the riprap barrier will not be undermined. Use this approach only where streambed degradation is

present. This process may require a series of such stream crossings in the same area to reduce the stream velocity through the area of potential bank erosion.

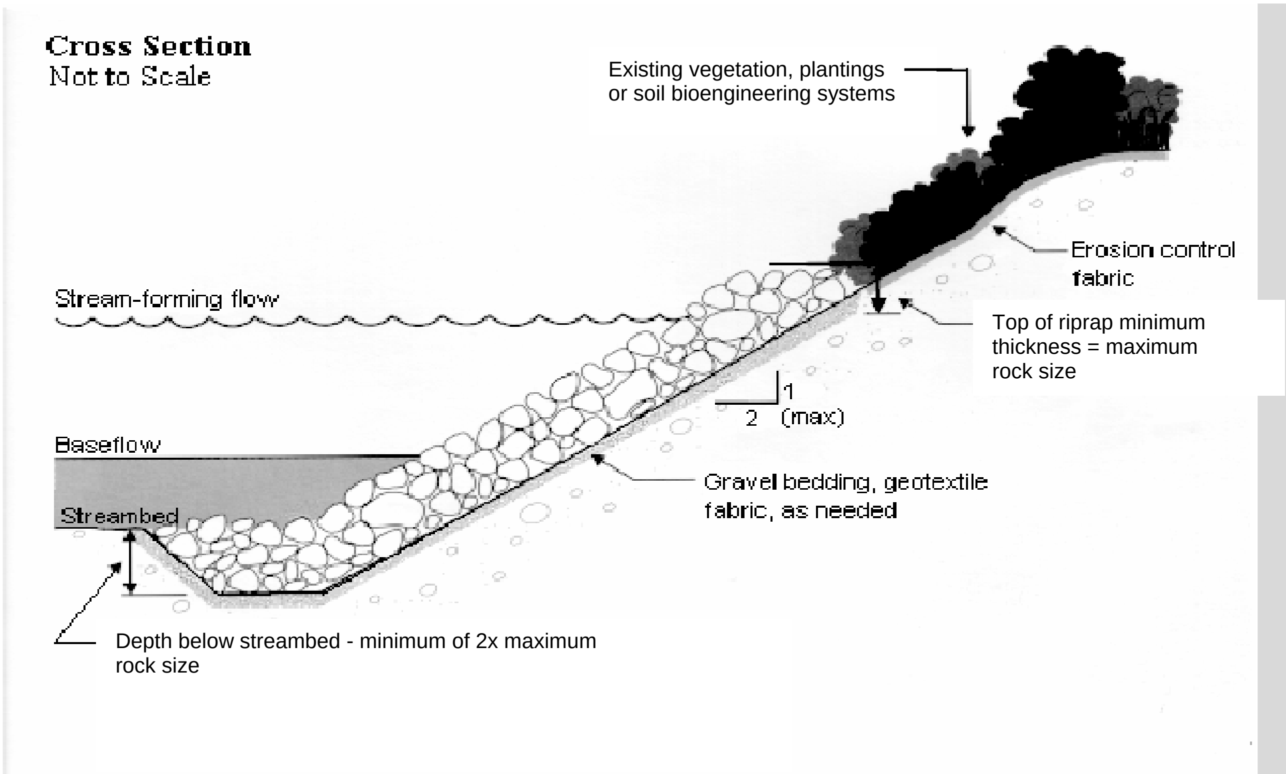


Figure 21. Cross-sectional view of riprap placement on the graded slope of a streambank

JETTY SYSTEM

A jetty system is a dike-like structure extending from the streambank out into the streambed. The dike or jetty protects the bank from erosion.

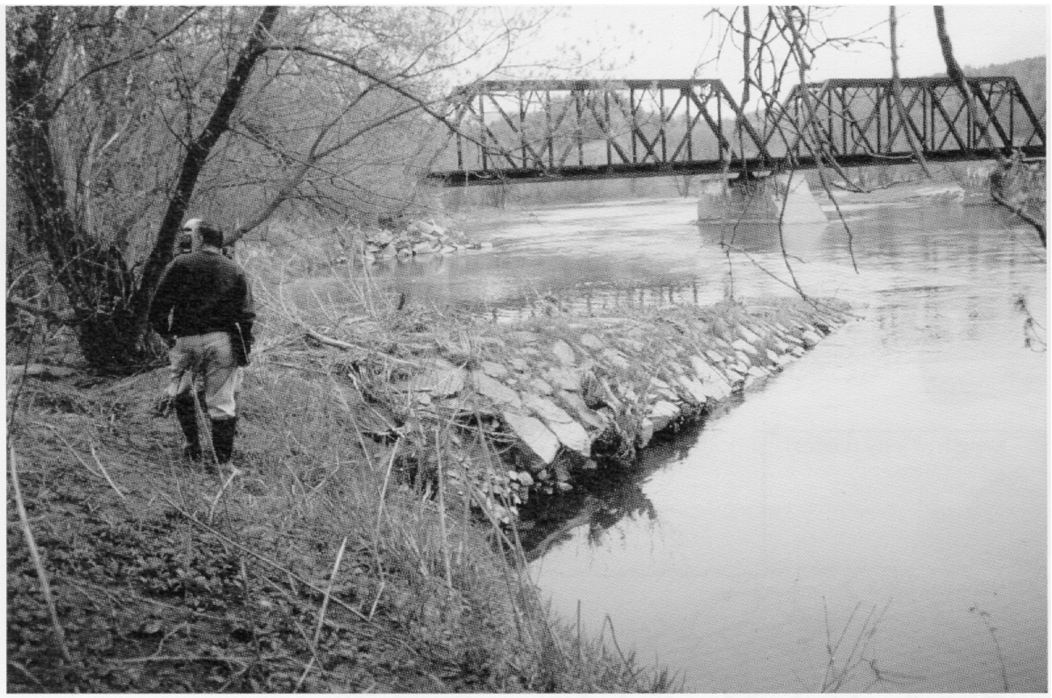


Figure 22. Stream jetty placement for bridge protection

Advantages and Disadvantages

- A jetty system can be used on various sizes of streams.
- A jetty system is an effective method of controlling erosion on bends.
- Jetties should be used with soil bioengineering upstream of the jetties, where sediment will be deposited.
- Professional design of the configuration and placement of each jetty is required.
- Materials and design can cause the jetty to be complex and expensive.

Materials

- Rock (see the Riprap section on page 9 and the previous section).

Preparation

- The rock size should be selected so that it will not be washed away when bank-full flow occurs.
- Before placing the jetties, the layout of the jetties should be determined.

- The length of each jetty should not exceed 25% of the width of the stream. Exceeding 25% of the stream width will encourage erosion of the opposite bank.
- The jetty should be spaced equal to 2 to 5 times the length of the jetty.

Installation

- Each jetty should be securely anchored into the bank and the bed to prevent washout or the stream from cutting around the jetty.
- The height of the jetty should be the height of the bank.
- The width of each jetty should be 8 to 12 feet.
- The sides of the jetty should have a 2-foot-horizontal to 1-foot-vertical (2H:1V) slope.

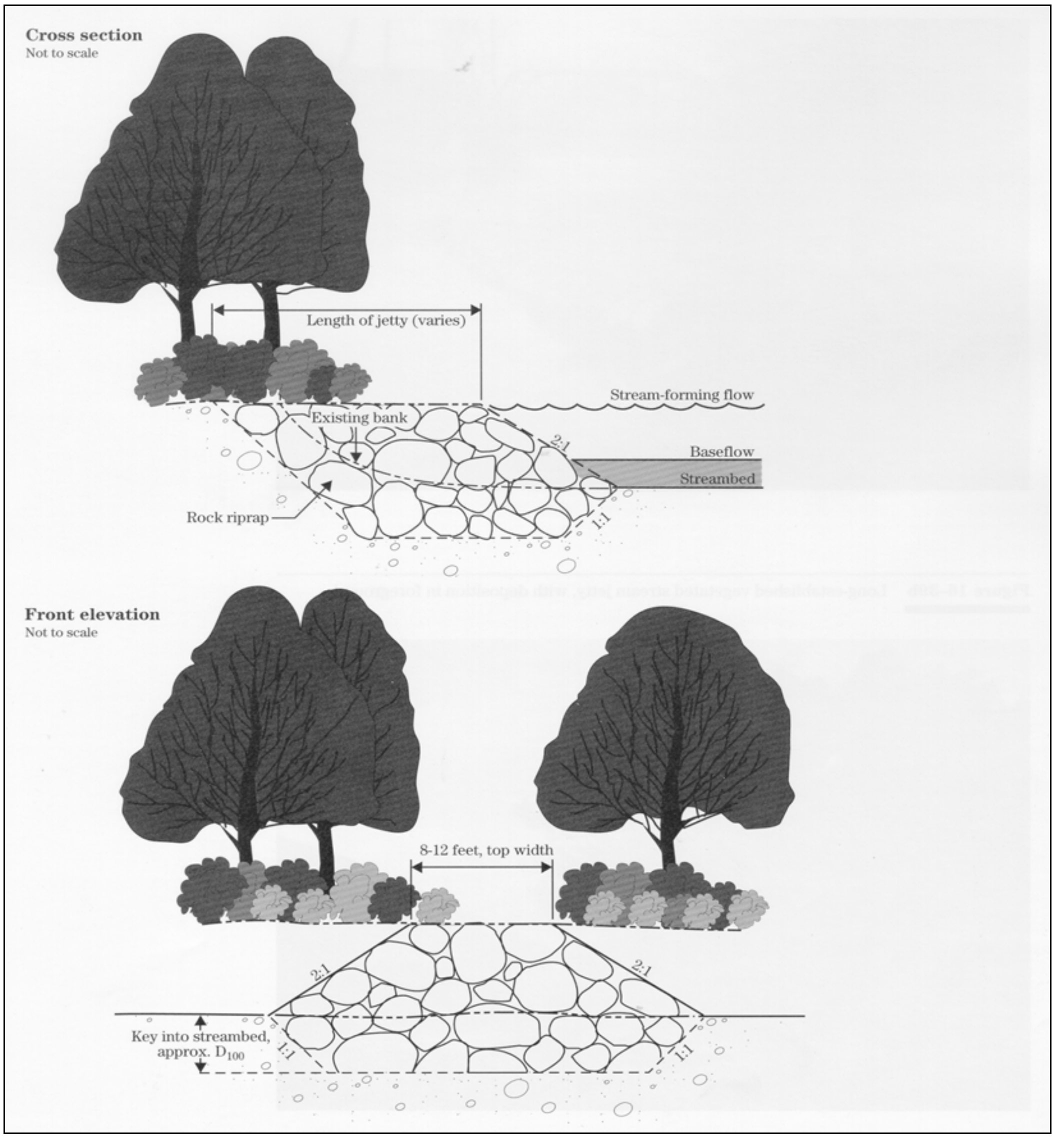


Figure 23. Stream jetty details

IOWA VANES

Iowa vanes are structures placed in an eroding streambed that cause the flow to be redirected, which results in the deposition of sediment on the eroding bank. When erosion occurs in the bend of a stream, the outside bank is significantly undermined by the flow from the straight portion of the stream colliding with the bank. The outside edge of the streambed is deepened as the bank erodes, but vanes stabilize the stream without affecting the sediment load and velocity of other parts of the stream.

Advantages and Disadvantages

- The toe of the bank is stabilized.
- Soil bioengineering should be used with the vanes to stabilize the bank. Once the sediment has been deposited at the bank, natural revegetation often occurs.
- The area of the channel or the sediment load upstream or downstream is not changed significantly.
- Iowa vanes are impractical for use in a narrow stream channel; the channel should be 15 to 20 feet wide.
- The vane system requires professional design.
- Iowa vanes should only be used in a sand bed channel.
- Vanes can tolerate ice flows and other debris because they are often submerged below the surface of the water.
- Vanes can cause damage to boats. Therefore, they should be clearly labeled with signs and buoys.
- Various types of materials can be used to create a submerged vane.

Materials

- Purchased, preformed Iowa vanes.
- Planks and pipe to construct vanes.
- Crane to lower prefabricated vanes into the water.
- Ram or hammer to drive the pipe into the streambed.

Preparation

- The simplest way to construct a stable vane is to use two metal tubes or pipes driven securely into the streambed.
- The pipes should be 6 to 9 feet apart and angled 20° to 25° toward the bank to establish the alignment of the vane against the stream.
- Planks should then be fastened between the tubes. Use the water surface as a reference point to level the planks.
- The length of each vane should be between 6 and 9 feet long.
- The height of each vane should be about 1 foot above average bed level or between 2 and 3 feet.

- Each vane should be no less than 1 to 3 inches in thickness at the top of the vane.
- Each vane should be completely submerged in average flow.

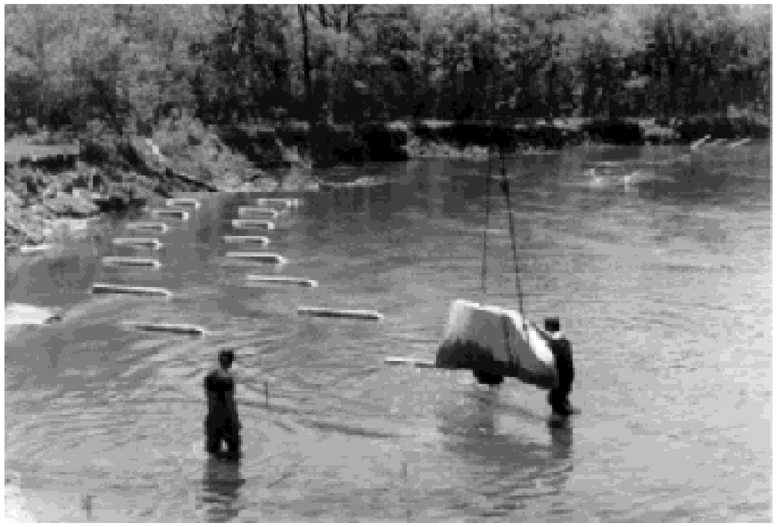
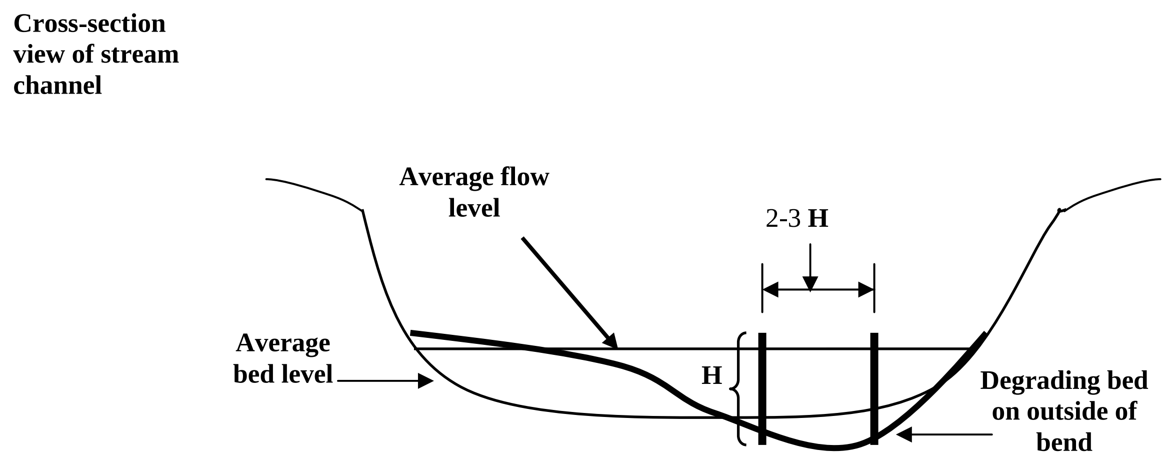


Figure 24. Installation of concrete Iowa vanes at low flow

Installation

- Installation of the vanes should begin at least one channel-width upstream from the bend where erosion is occurring.
- An array is a group of vanes next to each other; there should be 2 to 3 vanes in each array and at least three arrays before the area needing protection.
- The vanes within an array should be spaced 2 to 3 times the height of the vane.
- Between each array, there should be a distance of 15 to 30 times the height of a vane. The most upstream arrays can have a smaller amount of space between them, while those further downstream should have a greater distance between them, but not exceeding 30 times the height of the vane.
- Vanes do not need to be installed past the bend where erosion is occurring.



H = Height of vane used as a reference length for orientation of vane.

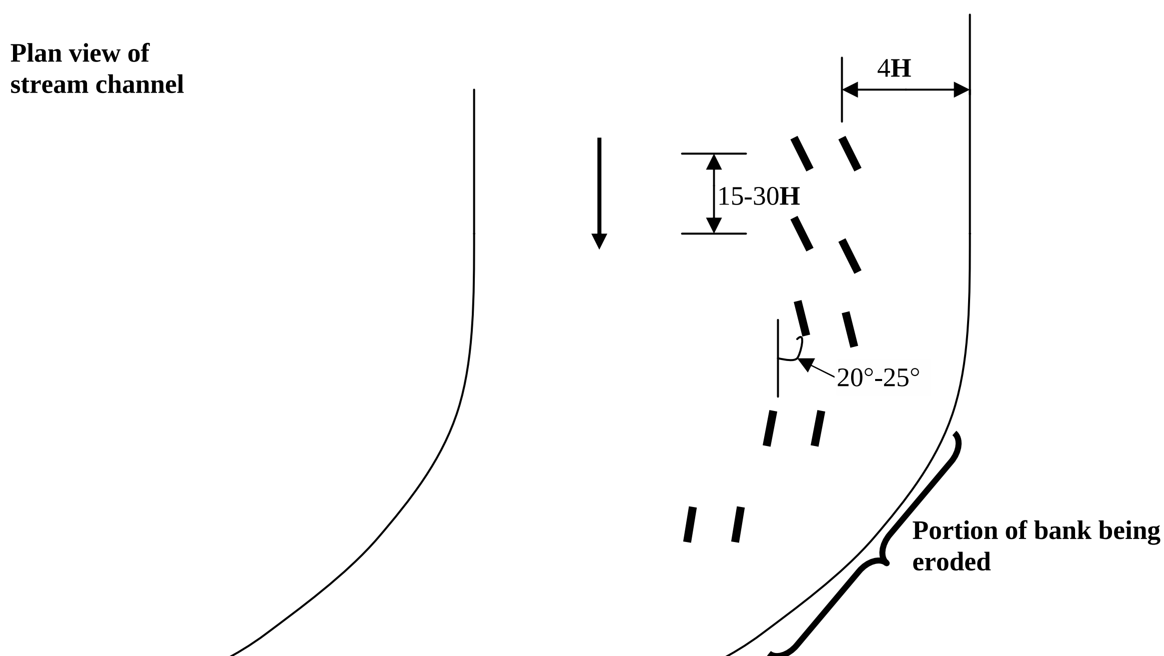


Figure 25. Iowa Vane placement details

Figure 26. Replacement of sediment on bank from Vanes

VEGETATED GEOGRIDS

Vegetated geogrids are the covering of soil with erosion control fabric (geotextile) on the slope of the bank. The erosion control fabric is secured by tucking it into the slope. Live cuttings are placed between the geogrids, and a root structure is established to bind the soil within and behind the geogrids. The toe of the bank is stabilized by layers of rock on top of the same geotextile fabric.

Advantages and Disadvantages

- Vegetated geogrids can be used where the bank cannot be pulled back to a gentle slope.
- Vegetated geogrids can be used where a bank has severely eroded.
- A large amount of soil and rock must be available to fill against the bank.
- Rapid vegetation growth is allowed from the live cuttings, which slows water during high water stages.

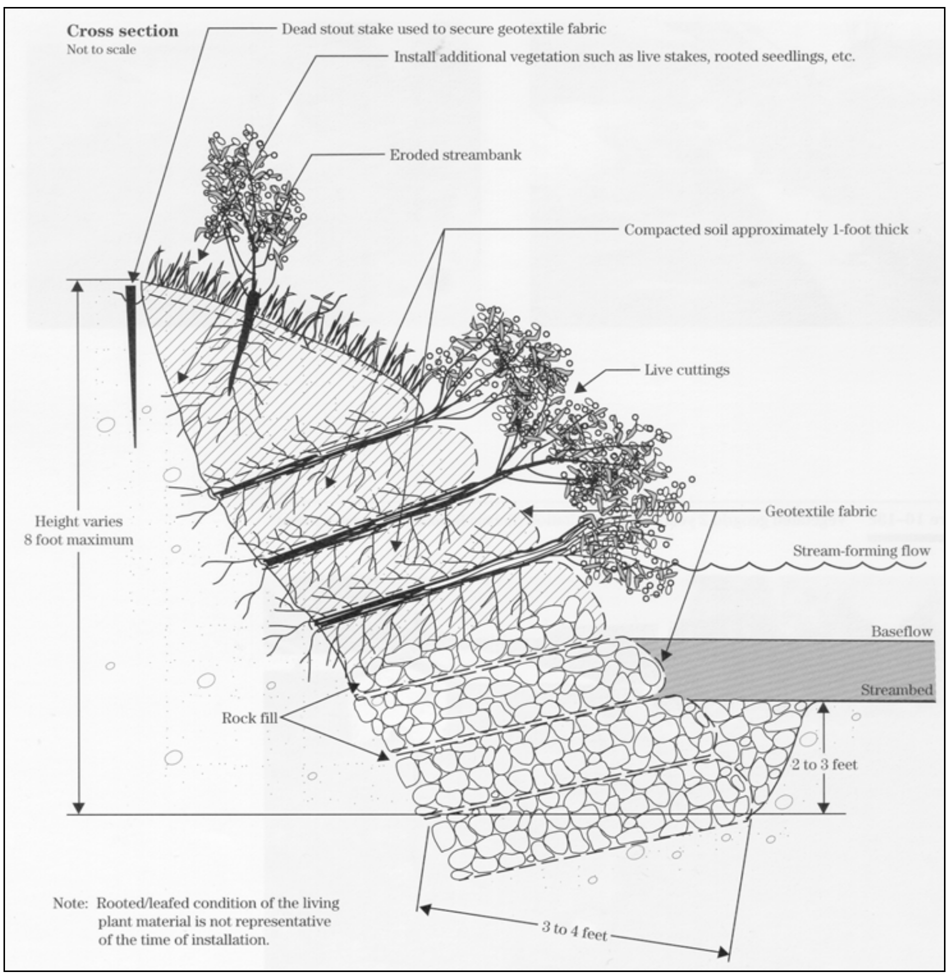


Figure 27. Vegetated geogrid details

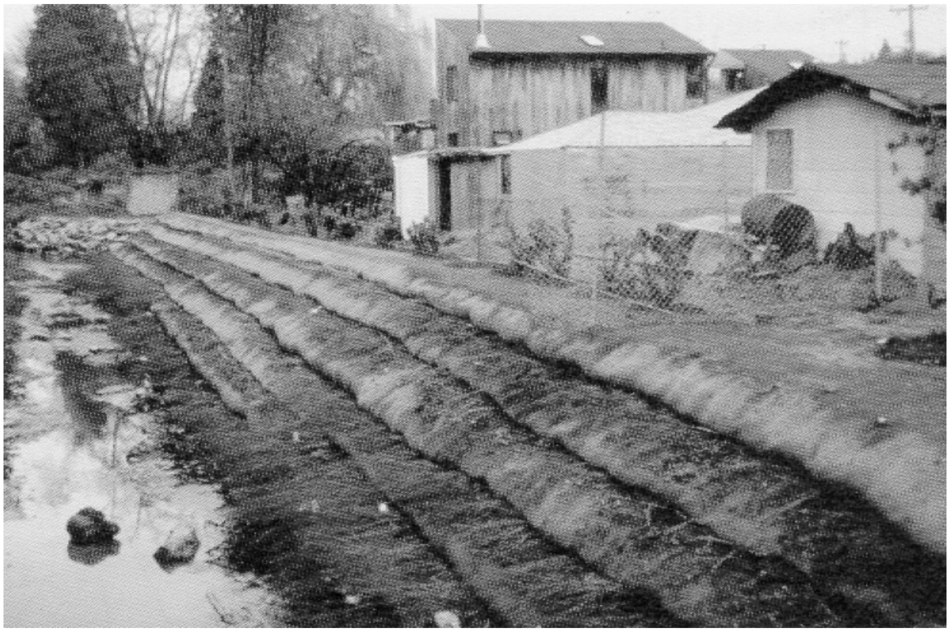


Figure 28. Completed geogrid installation

Figure 29. Vegetated geogrid two years after installation

Materials

- Branches 0.5 to 2.5 inches in diameter to reach to the existing bank.
- Rock fill with a diameter of 4 to 9 inches.
- Geotextile fabric/erosion control fabric.

Preparation

- The use of special excavation equipment to prepare the trench at the bank toe is required.
- Multiple personnel are required to layout the geotextile fabric layers and riprap.
- Prepare the live cuttings.

Installation

- Dig a trench 2 to 3 feet below the streambed.
- Fill the trench with rock and geogrid-wrapped rock up to the stream level.
- At the stream level, wrap a layer of rock and soil and then place the first layer of live cuttings between this and the next wrapped geogrid of soil.
- Each layer should become slightly shorter than the previous one to ensure the layers are not hanging over stream but are in contact with the original bank.
- Place topsoil on the top of the fabric on the last layer, plant with grasses, and stake the fabric to the original bank.

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APPENDIX A

The list given in this appendix is divided into two groups. The first group contains plants that are used in buffers at the tops of banks. The second group contains plants that are actually planted on the streambank slopes as part of bioengineering projects. Some of the large species of trees, such as the oaks, would not be planted on a reshaped bank, but would be planted at the top and beyond the lip of the bank.

Most of the species do not root well from unrooted cuttings on the site. Only the willows and, to a lesser extent, a few shrubs have the ability to begin with a stem stuck in the ground and experience a high percentage of rooting and growing. For the remaining species, seedlings or pre-rooted cuttings must be used. In these cases, planting is more time consuming. Willows are the least expensive and probably the most effective plant material for use in live stakes and fascines.

Plants used in buffers at the tops of banks:

Box Elder	*Acer negundo*
Red Maple	*Acer rubrum*
River Birch	*Betula nigra*
American Hornbeam	*Carpinis caroliniana*
Water Hickory	*Carya aquatica*
Bitternut Hickory	*Carya cordiformis*
Shagbark Hickory	*Carya ovata*
Honey Locust	*Gleditsia triacanthos*
White Oak	*Quercus alba*
Flameleaf Sumac	*Rhus copallina*

Plants planted on bank slopes as part of bioengineering projects:

Silver Maple	*Acer saccharinum*
Hackberry	*Celtis occidentalis*
Silky Dogwood	*Cornus amomum*
Roughleaf Dogwood	*Cornus drummondii*
Gray Dogwood	*Cornus racemosa*
Roundleaf Dogwood	*Cornus rugosa*
Red-Osier Dogwood	*Cornus sericea ssp sericea*
Green Ash	*Fraxinus pennsylvanica*
Black Walnut	*Juglans nigra*
Eastern Redcedar	*Juniperus virginiana*
Common Ninebark	*Physocarpus opulifolius*
Sycamore	*Platanus occidentalis*

Plants planted on the bank slopes as part of bioengineering projects (*continued*):

Eastern Cottonwood	*Populus deltoides*
Wild Plum	*Prunus angustifolia*
Common Chokecherry	*Prunus virginiana*
Swamp White Oak	*Quercus bicolor*
Bur Oak	*Quercus macrocarpa*
Black Locust	*Robinia pseuodoacacia*
Sandbar Willow	*Salix interior*
Black Willow	*Salix nigra*
Red Elderberry	*Sambucus racemosa*
Nannyberry	*Viburnum lentago*
American Cranberry Bush	*Viburnum trilobum*